

Amendment to the Claims

This listing of Claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims

1. (Currently Amended) A spin-valve magnetoresistive thin film element, comprising:

an antiferromagnetic layer;

a pinned magnetic film contacting said antiferromagnetic layer, wherein a magnetizing direction is pinned by an exchange coupling magnetic field between said pinned magnetic layer and said antiferromagnetic layer;

a free magnetic layer; and

a nonmagnetic electrically conductive layer formed between said free magnetic layer and said pinned magnetic layer, wherein a magnetizing direction of said free magnetic layer is aligned so as to intersect with said magnetizing direction of said pinned magnetic film;

wherein said pinned magnetic film includes a first pinned magnetic layer contacting said antiferromagnetic layer and a second pinned magnetic layer and a nonmagnetic intermediate layer therebetween, wherein said first pinned magnetic layer and said second pinned magnetic layer have different thicknesses;

wherein said antiferromagnetic layer comprises one of an X-Mn alloy, where X is selected from the group consisting of Pt, Pd, Ir, Rh, Ru, Os and combinations

thereof, and a Pt-Mn-X' alloy, where X' is selected from the group consisting of Pd, Ir, Rh, Ru, Os, Au, Ag and combinations thereof; and

wherein a thickness of said first pinned magnetic layer, a thickness of said second pinned magnetic layer, and a ratio of said thickness of said first pinned magnetic layer to said thickness of said second pinned magnetic layer are configured such that said exchange coupling magnetic field has an intensity of at least about 1 kOe.

2. (Original) A spin-valve magnetoresistive thin film element according to Claim 1, wherein said antiferromagnetic layer comprises a PtMn alloy.

3. (Original) A spin-valve magnetoresistive thin film element according to Claim 1, wherein said antiferromagnetic layer comprises a Pt-Mn-Pd alloy.

4. (Currently Amended) A spin-valve magnetoresistive thin film element according to Claim 1, wherein a said ratio of said thickness of said first pinned magnetic layer and said thickness of said second pinned magnetic layer is in a range selected from the group consisting of about 0.53 to about 0.95 and about 1.05 to about 1.8.

5. (Original) A spin-valve magnetoresistive thin film element according to Claim 1, wherein a film thickness of said first pinned magnetic layer and a film thickness of said second pinned magnetic layer are both in a range of about 10 to 50 angstroms, and wherein an absolute value of film thickness of said first pinned magnetic layer minus said film thickness of said second pinned magnetic layer is at least about 2 angstroms.

6. (Original) A spin-valve magnetoresistive thin film element according to Claim 1, wherein the thickness of said nonmagnetic intermediate layer is in a range of about 4.0 to about 9.4 angstroms.

7. (Original) A spin-valve magnetoresistive thin film element according to Claim 1, wherein the thickness of said nonmagnetic intermediate layer is in a range selected from the group consisting of about 2.8 to about 6.2 angstroms and about 6.8 to about 10.2 angstroms.

8. (Original) A spin-valve magnetoresistive thin film element according to Claim 1, wherein the thickness of said antiferromagnetic layer is in a range of about 100 to 200 angstroms.

9. (Currently Amended) A thin film magnetic head, comprising shield layers formed above and below ~~the~~ a spin-valve magnetoresistive thin film element according to Claim 1, with gap layers therebetween,

the spin-valve magnetoresistive thin film element comprising:

an antiferromagnetic layer;

a pinned magnetic film contacting said antiferromagnetic layer, wherein a magnetizing direction is pinned by an exchange coupling magnetic field between said pinned magnetic layer and said antiferromagnetic layer;

a free magnetic layer; and

a nonmagnetic electrically conductive layer formed between said free magnetic layer and said pinned magnetic layer, wherein a magnetizing direction of said free magnetic layer is aligned so as to intersect with said magnetizing direction of said pinned magnetic film;

said pinned magnetic film including a first pinned magnetic layer contacting said antiferromagnetic layer and a second pinned magnetic layer and a nonmagnetic intermediate layer therebetween, wherein said first pinned magnetic layer and said second pinned magnetic layer have different thicknesses;

said antiferromagnetic layer comprising one of an X-Mn alloy, where X is selected from the group consisting of Pt, Pd, Ir, Rh, Ru, Os and combinations thereof, and a Pt-Mn-X' alloy, where X' is selected from the group consisting of Pd, Ir, Rh, Ru, Os, Au, Ag and combinations thereof; and

a thickness of said first pinned magnetic layer, a thickness of said second pinned magnetic layer, and a ratio of said thickness of said first pinned magnetic layer to said thickness of said second pinned magnetic layer being configured such that said exchange coupling magnetic field has an intensity of at least about 1 kOe.

10. (Original) The spin-valve magnetoresistive thin film element according to Claim 1, wherein said nonmagnetic intermediate layer comprises at least one element selected from the group consisting of Ru, Rh, Ir, Cr, and Re.

11. (Currently Amended) The spin-valve magnetoresistive thin film element according to Claim 1, wherein said thickness of said first pinned magnetic layer, said thickness of said second pinned magnetic layer, and said ratio of said thickness of said first pinned magnetic layer to said thickness of said second pinned magnetic layer are configured such that said exchange coupling magnetic field has a intensity of at least about 2 kOe.

12. (Currently Amended) The spin-valve magnetoresistive thin film element according to Claim 1, wherein said thickness of said first pinned magnetic layer, said thickness of said second pinned magnetic layer, and said ratio of said thickness of said first pinned magnetic layer to said thickness of said second pinned magnetic layer are configured such that said exchange coupling magnetic field has an intensity of at least about 3.5 kOe.

13. (Currently Amended) A spin-valve magnetoresistive thin film element, comprising:

an antiferromagnetic layer;

a pinned magnetic film contacting said antiferromagnetic layer, wherein a magnetizing direction is pinned by an exchange coupling magnetic field between said pinned magnetic film and said antiferromagnetic layer; and

a free magnetic layer;

a nonmagnetic electrically conductive layer formed between said free magnetic layer and said pinned magnetic film, wherein a magnetizing direction of said free magnetic layer is aligned so as to intersect with the magnetizing direction of said pinned magnetic film;

wherein said pinned magnetic film includes a first pinned magnetic layer contacting said antiferromagnetic layer and a second pinned magnetic layer and a nonmagnetic intermediate layer therebetween, said first pinned magnetic layer and said second pinned magnetic layer each having a saturation magnetization M_s and a film thickness t ;

wherein a product of said saturation magnetization M_s and said film thickness t is a magnetic film thickness, wherein said first pinned magnetic layer and said second pinned magnetic layer have different magnetic film thicknesses;

wherein said antiferromagnetic layer comprises one of an X-Mn alloy, where X is selected from the group consisting of Pt, Pd, Ir, Rh, Ru, Os and combinations thereof, and a Pt-Mn-X' alloy, where X' is selected from the group consisting of Pd, Ir, Rh, Ru, Os, Au, Ag and combinations thereof; and

wherein a thickness of said first pinned magnetic layer, a thickness of said second pinned magnetic layer, and a ratio of said thickness of said first pinned magnetic layer to said thickness of said second pinned magnetic layer are configured such that said exchange coupling magnetic field has an intensity of at least about 1 kOe.

14. (Original) A spin-valve magnetoresistive thin film element according to Claim 13, wherein said antiferromagnetic layer comprises a PtMn alloy.

15. (Currently Amended) A spin-valve magnetoresistive thin film element according to Claim 13, wherein a said ratio of said magnetic film thickness of said first pinned magnetic layer and said magnetic film thickness of said second pinned magnetic layer is in a range selected from the group consisting of about 0.53 to about 0.95 and about 1.05 to about 1.8.

16. (Original) A spin-valve magnetoresistive thin film element according to Claim 13, wherein said film thickness of said first pinned magnetic layer and said film thickness of said second pinned magnetic layer are both in a range of about 10 to

50 angstroms, and wherein the absolute value of said film thickness of said first pinned magnetic layer minus said film thickness of said second pinned magnetic layer is at least about 2 angstroms tesla.

17. (Original) A spin-valve magnetoresistive thin film element according to Claim 13, wherein said thickness of said nonmagnetic intermediate layer is in a range of about 4.0 to about 9.4 angstroms.

18. (Original) A spin-valve magnetoresistive thin film element according to Claim 13, wherein said thickness of said nonmagnetic intermediate layer is in a range selected from the group consisting of about 2.8 to about 6.2 angstroms and about 6.8 to about 10.2 angstroms.

19. (Original) A spin-valve magnetoresistive thin film element according to Claim 13, wherein the thickness of said antiferromagnetic layer is in a range of about 100 to about 200 angstroms.

20. (Original) The spin-valve magnetoresistive thin film element according to Claim 13, wherein said nonmagnetic intermediate layer comprises at least one element selected from the group consisting of Ru, Rh, Ir, Cr, and Re.

21. (Currently Amended) A thin film magnetic head, comprising shield layers formed above and below ~~the~~ a spin-valve magnetoresistive thin film element ~~according to Claim 13~~, with gap layers therebetween,

the spin-valve magnetoresistive thin film element comprising:

an antiferromagnetic layer;

a pinned magnetic film contacting said antiferromagnetic layer, wherein a magnetizing direction is pinned by an exchange coupling magnetic field between said pinned magnetic film and said antiferromagnetic layer; and

a free magnetic layer;

a nonmagnetic electrically conductive layer formed between said free magnetic layer and said pinned magnetic film, wherein a magnetizing direction of said free magnetic layer is aligned so as to intersect with the magnetizing direction of said pinned magnetic film;

said pinned magnetic film including a first pinned magnetic layer contacting said antiferromagnetic layer and a second pinned magnetic layer and a nonmagnetic intermediate layer therebetween, wherein said first pinned magnetic layer and said second pinned magnetic layer each have a saturation magnetization M_s and a film thickness t ;

a product of said saturation magnetization M_s and said film thickness t being a magnetic film thickness, said first pinned magnetic layer and said second pinned magnetic layer having different magnetic film thicknesses;

said antiferromagnetic layer comprising one of an X-Mn alloy, where X is selected from the group consisting of Pt, Pd, Ir, Rh, Ru, Os and combinations thereof, and a Pt-Mn-X' alloy, where X' is selected from the group consisting of Pd, Ir, Rh, Ru, Os, Au, Ag and combinations thereof; and

a thickness of said first pinned magnetic layer, a thickness of said second pinned magnetic layer, and a ratio of said thickness of said first pinned magnetic layer to said thickness of said second pinned magnetic layer being configured such that said exchange coupling magnetic field has an intensity of at least about 1 kOe.

22. (Currently Amended) The spin-valve magnetoresistive thin film element according to Claim 13, wherein said thickness of said first pinned magnetic layer, said thickness of said second pinned magnetic layer, and said ratio of said thickness of said first pinned magnetic layer to said thickness of said second pinned magnetic layer are configured such that said exchange coupling magnetic field has an intensity of at least about 2 kOe.

23. (Currently Amended) The spin-valve magnetoresistive thin film element according to Claim 13, wherein said thickness of said first pinned magnetic layer, said thickness of said second pinned magnetic layer, and said ratio of said thickness of said first pinned magnetic layer to said thickness of said second pinned magnetic layer are configured such that said exchange coupling magnetic field has an intensity of at least about 3.5 kOe.

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24. (Original) A spin-valve magnetoresistive thin film element according to Claim 13, wherein said antiferromagnetic layer comprises a Pt-Mn-Pd alloy.